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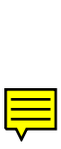

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VEHICLE TRACKING SYSTEMS

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One of the earliest tracking systems was used for the purpose of documenting migration patterns of animals.

Through the years, ships have used the sextant and stars to determine their location at sea, and aircraft have used maps and developed radio equipment for that purpose. The capability of locating ships and aircraft from a central location has been important. Radar was developed to help accomplish this.

The need for locating vehicles as well has arisen in the past few years. At this time, two types of tracking need developing:

1. Capability of the vehicle to determine its own location.
2. Capability of determining the position of all vehicles from a central location.

To date, several systems have been developed to accomplish vehicle location. The systems consist of three types: Dead Reckoning, Satellite, and LORAN C. If the information is to be sent back to a central location, some type of radio communication system is needed. One can use the existing voice radio or add a radio system just for transmitting the data.

DEAD RECKONING SYSTEMS

This system consists of sensors attached to the front wheels of a vehicle to determine the direction and distance traveled. A compass can also be added to help with establishing direction. The sensor information is received by a local processor calculating the vehicle's location relative to its starting point. The processor has the capability of driving a local display showing the maps of the area in which the vehicle is traveling. It can also send the information back to a central location. This type equipment works well with automobiles but would not work with ships or aircraft. The accuracy of the system can be very good depending on the sensors used.

LORAN C SYSTEMS

Several versions of LORAN have been developed. LORAN C was built to provide improved navigation capability for the Coast Guard along the coast of the U. S. and the Great Lakes. Loran C consists of powerful pulsed radio transmitters operating at 100 KHz.

LORAN is an acronym for Long Range Navigation. The "C" refers to the version. The L. F. radio band was used to provide propagation by ground wave. The system consists of fixed land based transmitters that are organized into groups called chains. Each chain consists of one master transmitter and up to four secondary stations. Each chain is assigned a time code or G.R.I. Group Repetition Interval. G.R.I. is the time from the start of the master pulses and the beginning of the next master pulse. The secondary pulses are sent between the master pulses. The master station transmits a group of 8 pulses one millisecond apart, and a 9th pulse two milliseconds later to identify it as the master pulse. The secondary station consists of 8 pulses one millisecond apart. Each secondary station will transmit after a time interval identified as coding delay. The delay is the time from the start of the master pulse group to the start of secondary pulse group. Each station is assigned its own separate coding delay.

LORAN C works on time measurement. A receiver is given the master and secondary pulses and comes up with a TD or Time Difference. A TD is measured from the master to a secondary group. Two TDs are needed to calculate latitude and longitude. There are approximately 17 LORAN chains in the world today. Four of these operate within the United States. The part of the United States that is not covered at this time includes certain parts of the middle states. During the next two years, three new chains will be added to give complete coverage of the United States. With this equipment, it is possible to have both a local display and the ability to send the information to a central location for display.

LORAN C can be used by ships for which it was designed, aircraft, and land vehicles. Accuracy can be from 60 to 100 feet. Accuracy depends on location in regard to the master and secondary station.

SATELLITE SYSTEMS

One can divide satellite systems into several types now in operation or types in the planning stage. At this time, the systems will be addressed as three types; single, double, and multi-satellite.

SINGLE SATELLITE SYSTEM

This is a satellite in a polar orbit called Transit. It was designed for marine use. The satellite passes over the United States once a day. In New Mexico, it is available for about 60 minutes a day. It transmits time and other data which a receiver can decode and transmit location information. Accuracy is about one mile. After receiving several passes, the accuracy improves.

DOUBLE SATELLITE SYSTEMS

A signal with a signature code and time code is sent from a base station to a satellite. The satellite relays the signal to the vehicle. The vehicle retransmits the signal to both satellites which, in turn, relay it back to the base. The base calculates the time it took to receive the return reply. Knowing the location of the satellites and time of day, the base can calculate the vehicle's location. The base can then send the information to a central location that will display the information. Its projected accuracy is to be under 50 feet.

MULTI SATELLITE SYSTEMS

This system is called Global Positioning System or G.P.S. Each satellite will send information a receiver can use. The receiver needs to pull information from at least three satellites to calculate its position. The information can then be sent back to a central location through the satellite message channel or through another radio system. At this time, there are 7 satellites of the planned 18 in operation, resulting in three to four hours of use in a day.

The accuracy of the system is within 200 meters. It can provide latitude longitude, plus altitude information. It can provide both local display and remote display. At the present time, land surveyors make use of the system.

With all satellite systems, problems exist when operating near tall buildings and in mountain canyon areas.

COMBINATION SYSTEMS

To increase accuracy and solve other problems, many companies are planning to use combination of systems. For instance, adding a Dead Reckoning System to a LORAN C could increase accuracy.

LOCAL READ-OUTS

Local read-outs can vary. Uoually, they consist of a map with the vehicle shown on the map. Ships and aircraft have read-outs that give them latitude and longitude information.

CENTRAL STATION DISPLAYS

Again, the most common display is a map, or groups of maps, of the area showing the vehicle moving on the screen. A separate screen showing the

latitude and longitude of the vehicles as they move around may be used. Displays are also available that show the location of the vehicle in relation to landmarks.

Most systems come with a logging printer. Some equipment has output allowing storage of information on audio cassette recorders as well as hard disk drives. Interfaces are also available to work with computer aided dispatch systems.

OTHER USES OF A TRACKING SYSTEM

Since tracking systems using central read-outs have some means of transmitting the data to a central location, other information can be added. Most systems have the ability to send status information. The vehicle operator can send codes such as 10-7 or 10-8 to the central system. Duress is also available and some companies offer remote duress operation for police departments.

Since data is being sent back and forth, it is possible to add a key board and a display so the vehicle operator and someone at the central display can talk using digital transmission in place of voice communication. In the future, new uses for tracking equipment will come about, resulting in lower equipment cost.